Title	Generating inferences in oral text comprehension : a study on preschool children
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Citation	Law, W. B. [羅穎璁]. (2012). Generating inferences in oral text comprehension : a study on preschool children. (Thesis). University of Hong Kong, Pokfulam, Hong Kong SAR.
Issued Date	2012
URL	http://hdl.handle.net/10722/237909
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Generating inferences in oral text comprehension: A study on preschool children.

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A dissertation submitted in partial fulfilment of the requirements for the Bachelor of Science (Speech and Hearing Sciences), The University of Hong Kong, June 30, 2012.

Abstract

This study investigated inferential comprehension of oral text in preschoolers and its relationship with working memory and receptive ability. Forty-eight preschoolers age ranging from 3;00-5;11 participated in the study. They listened to four stories and answered all together twenty-four inferential questions; with twelve questions for knowledge-based and text-based inference each. Within text-based inference, four questions were asked on each causal, referential and character's emotion inference.

The result showed children's ability in generating inference improved with increase age. Additional, the children performed better in generating text-based than knowledge-based inference. Regarding the three types of text-based inference, there was a significant interaction effect. Early emergency of causal and character's emotion inference was noted at age 4 while development of referential inference started at age 5. Multiple regressions suggested working memory and receptive ability makes unique contribution in inference generation. Suggestions for further research were made.

Generating inferences in oral text comprehension: A study on preschool children.

Inference generation refers to the ability to identify implicit relationship in explicit information presented in the text to establish a coherent comprehension of its meaning and the speaker's intention. It often requires the use and integration of previously acquired knowledge or general knowledge of the world (Kintsch & Kintsch, 2005).

Previous works found that inference generation contributes to reading success. In particular, inference generation ability is a strong indicator in distinguishing good readers from poor readers, with good readers better at inference generation (van den Broek et. al, 2005; Bowyer-Crane & Snowling, 2005). Majority of studies on inference generation were based on reading comprehension of school-age children and suggested the different components necessary for inference generation might yet to develop in young children (Cain, Oakhill, & Bryant., 2004).

van den Broek et. al (2005) argued that inference generation starts to develop well before school-age and young children in fact generate the same inferences as do adults but in less complex contexts with appropriate testing material. For example, in Wenner & Bauer (2001), 2-year old children demonstrated the ability to identify causal relations between three-event-sequences that they experienced. Therefore, in the current study, materials were designed based on familiar events which young children encounter in daily life, to ensure they readily have the world knowledge and experience required for generating the inferences.

Many studies revealed that a relation between listening text comprehension in preschool and reading comprehension in school-age children has been shown (Storch & Whitehurst, 2002; Kendeous, van den Broek, White, & Lynch., 2009). These studies evidenced that the comprehension processes involve in reading and listening text comprehension are the same. This implies that inference generation can be applied and readily observed through listening comprehension at an earlier age prior to the development of reading comprehension. Given the importance of inference generation as a predictor for later reading comprehension ability and the limited existing literature on early development of inference generation in listening comprehension, this current study will investigate inference generation in oral text comprehension in preschoolers.

Research on inferential comprehension of oral text in preschool and early school-age children, especially in Cantonese speaking children, is scarce. Previous student dissertation investigated the use of three types of inferences in oral text of two stories in Cantonese-speaking children age 4;7-7;0 (Wong, 1994). The study adopted the scheme in Hudson & Slackman (1990), in which inferences were classified by the knowledge base from which they are generated from. Script-based inferences are generated from knowledge scripts of familiar events similar to knowledge-based inference (to be discussed later) , invited-text inference is derived from contexts of propositions in text similar to text-based inference (to be discussed later) and logical-text inference is drawn from interpretation of conditional

connective “if”; the former two types of inferences explored causal-relation in the story. The result suggested that older children performed significantly better than younger children in drawing inferences. Among all inferences investigated, children aged 4;7-7;0 performed best in drawing script-based inference and ceiling effect was noted in 4-year-old group. In comparing invited-text with logical-text inference, the no significant performance difference was noted in children aged 4;7-6;0 and 6;7-7:0 whereas children aged 6;1-6;6 performed better with logical-text than invited-text inferences. As Wong (1994) failed to find the age of emergence of children’s inference generation , this current study aimed to fill this research gap to explore inference generation in younger children aged from 3;00-5;11.

Critical review of the task design of Wong (1994) suggested that the script-based questions themselves ready contained partially explicit information that gave cues to target answer. Such that, script-based inferences were drawn based on general knowledge relevant to the cue in questions and did not required referencing to in story content. Illustrated by an example from Wong (1994), the script-based questions “why did Chi Keung blow out the candle?” itself provided the explicit information “blow out the candle”; based on general knowledge, the children could ready drawn the answer “because it’s his birthday” without integrating with the story content. However, a true knowledge-based inference should involve process of incorporating previously learnt world knowledge into the relevant information within the story context (Florit & Levorato, 2011). This suggested the script-based inference

in Wong (1994) was too easy to be made with the cue in the questions, hence, explain for the ceiling effect was noted in 4-year-old group. Therefore, the current study aimed to investigate the preschool children's ability in drawing true knowledge-based inference which involves integration of story content and general knowledge. Illustrated with an example in the current study, with the knowledge-based question "what special day is it today?", and children have to integrate explicit information in story "getting present", "having cake" and "blowing out candles" with their previous world knowledge to infer the answer "it's Zi Zai's birthday." The question that arose in here is that whether the result in Wong (1994) that children performed better in knowledge-based inference over text-based inference held after true knowledge-based inference are examined.

This study also adopted a different taxonomy of inferences to investigate two types of inferences that children commonly made during comprehension: knowledge-based and text-based inferences (Florit & Levorato, 2011). The former requires incorporating previously acquired world knowledge with explicit information in the story; the latter instead, require identifying meaningful relations between pieces of explicit information within the story. Considering that in Wong (1994), only causal relation of inference was explored and the fact that a variety of relations can be generated from text inference has yet to be examined. Therefore, in this current study extended from Wong (1994) to explore and provide a more comprehensive on the development of different types of inferences within text-based

inference in pre-schoolers. Graesser, Singer and Trabosso (1994) illustrated difference types of text-based inference but no report on developmental order of these inferences. Three specific types of text-based inferences that are necessary and important in establishing coherent comprehension of oral story were examined in this current study; they were referential, casual and character's emotion inferences. Referential inference was drawn by identifying pronominal tie between phrases; causal inference was made by identifying causal-consequence relation between events; and character's emotion inference was drawn by inferring character's emotion in response to story event. Cozijn (2000) discussed how different inference types may differ and two aspects were in particularly specific to these three types of text-based inferences: the moment when the inference was made and the direction of inference was formed. Therefore, the question arose here was whether some of these text-based inferences were more easily generated and acquired than others by pre-schooler.

Successful inference generation requires construction of a mental representation in which explicit and implicit information are organized and integrated with previously known knowledge of the world to form meaningful relations (Florit & Levorato, 2011; van den Broek et. al, 2005). According to Hannon & Daneman 2001, the construction process of a coherent mental representation depends on numerous components which have the potential to give rise to individual differences in performance. Adam, Bourke & Willis (1999) found a

relation between working memory and listening comprehension including linguistic components and inference making in children aged 4;06 and 5;06, but yet reveal its specific association with inference generation. It suggested that one of the crucial component attribute to process of inference generation could be working memory, as we actively maintained and manipulated the incoming information to build the metal representation. A question arose here is that whether working memory also contributes to inference generation apart from literal oral text comprehension? Potentially, working memory may attribute more to knowledge-based than text-based inference as the former involved retrieval of known world knowledge in long term memory and integration with explicit information simultaneously (Graesser et. al, 1994). Adam et. al (1999) evaluated the use of listening word span test in examining working memory and found the task was too difficult for the children and they produced a very limited range of scores. Therefore, current study has adapted similar methodology used in Alloway, Gatherole, and Pickering (2006) which backward digit span task involving only single digit number will be used to evaluate children's working memory, aiming at reducing the stimuli complexity as they were more familiar with numbers.

In addition, van den Broek et. al (2005) revealed comprehension of explicit information is another important component for success in mental representation construction process. It was assumed that with advanced receptive comprehension ability, one can interpret and incorporate information more accurately to form a coherent mental representation which is

fundamental for inference generation. In order to gain better understanding of inference generation development, this study explored the extent of how receptive ability and working memory contribute respectively to inference generation. Furthermore, how these factors together account for specific types of inference in preschool children were also examined.

Hypothesis

We hypothesis that 1) children across age should perform better on knowledge-based than text-based inferences at early age, but such discrepancy should decrease with increasing age. 2) Children perform differently among the three types of text-based inference. 3) Working memory and receptive ability at sentence level have a unique and significant contribution to inference making respectively.

Method

Participants

Forty-eight Cantonese-speaking children aged 3;0 and 6;0 years were recruited for this study. Sixteen children, eight boys and eight girls in each group representing one year age interval; 3-year-old group (age mean = 3:06, SD= 3 month), 4-year-old group (age mean = 4:06, SD = 4 months) and 5-year-old group (age mean =5:06, SD =3 months). Children were selected randomly from four kindergartens from 3 different districts. Children reported with no parental concern of speech and language development and no reported history of hearing and no speech and language problem.

Materials

Four stories were designed for this study, with content based on daily experience scenario of children around theme of familiar place, festival and event (e.g birthday party, a day out in park and beach & Christmas day (Appendix 1)). Each story was around 120 to 130 words. Simple sentences were used to ensure that linguistic complexity of the stories was appropriate for pre-schoolers. The stories were recorded in four sound files by the same female speaker to keep the intonation, stress and speech rate similar. In addition, matching with each story, a story scene picture was created with minimal details of characters and story content, information relating to inference questions was avoided in the picture. These pictures were presented to the participant during listening to the story with purpose to retain participant motivation and interest throughout the task.

Participants' response was taped-recorded and scored according to criteria developed after piloting with four children aged 3;03 , 3;09, 4;06 and 5;05. The piloting revealed that some responses were relevant but marginal to the accurate answers which were difficult to judge. For example, with text-based (causal) question for the birthday story, "why did Ka Ming get lost?", the marginal response noted was "he walked away" whereas the accurate answer should be "He followed another child and walked away". Therefore, a criterion of scoring was derived increase judgment consistency and scoring reliability; point 1was given when the answer is relevantly and specifically accurate while no point was given for marginal

relevant answer. For each story, a total of six inferential questions were asked, each accounts for one point, three from knowledge-based inference and three from text-based inference questions; the latter included one question for referential inference, causal inference and character's emotion inference. (Appendix 1)

Procedure

Each child was seen individually in his/her kindergarten. After a short conversation of rapport building, the child was administrated inference generation task, backward digit span task and Reynell Developmental Language Scales: Receptive language assessment (RDLS-R) in a randomized order.

For inferential generation task, the experimenter firstly presented the picture for the story and introduced the characters to the participant. Participant was asked to recall the name of the characters. Then, the story was presented to participant twice to allow an overview of the story plot. Afterwards, inferential questions were asked. The four stories were presented in randomized order. Participant's response was scored online according to the criteria.

Backward digit span task was carried out to examine children's working memory. The digit span stimuli were designed by series of randomized single digit number (1 to 9) which the children had to repeat in a reverse order. Prior to actual data collection, demonstration and explanation were given on different digits span level (range 2-4) by the experimenter who presented the series of number orally and written on board simultaneously. Then, with oral

and written presentation of the series, the children had two trials at each 2, 3 and 4 digits span level to demonstrate they fully understood the task. For actual data collection, written material was removed and children were required to attend only to the orally stimuli, the task started at 2 digit span level. Three series of numbers were presented for each digit span level. Children required performing accurately at least two out three series in order to proceed to the next digit span level. Participant's performance was scored according to a) maximum length of digit span achieved (possible range 2-5 digits), and b) number accurately trial performed out of three at that level (1/3 = 0.3; 2/3 = 0.6; 3/3 = 0.9). For example, if a child was correct on 2 series out of 3 at 2 digits span level but unable to perform any series at 3 digits span level, will receive 2.6 points.

The receptive subtest of the Chinese version (Hong Kong Society for Child Health and Development, 1987) of Reynell Developmental Language Scales, RDLS-R (Reynell & Huntley, 1985) was used to examine children's receptive ability. The test was standardized for Cantonese children (age range 1-7) to evaluate their listening comprehension of questions, and various sentences of different length and complexity level with a variety of concepts. There were ten sections with 67 items each items scoring one point.

Reliability testing

The experimenter randomly chose recording tape for five children for rescoring on their inference answers three weeks after the experiment; inter-rater reliability was 100%. One

independent coder also participated in the reliability testing; intra-rater reliability was 95%.

Results

Knowledge-based and text-based inference

Figure1 below illustrates children's performance on knowledge-based and text-based inference across age groups. The age groups (3) X types of inferences (2) ANOVA revealed that there was a significant main effect of inference types, $F(1, 45) = 12.78$, $p < .001$. The children scored significantly higher on text-based than knowledge-based inferences. There was also a significant main effect of age groups, $F(2,45) = 45.24$, $p < .001$. Post-hoc multiple comparison analysis revealed that the 5-year-old group did better than the 4-year-old group ($p < .001$) and the 3-year-old group ($p < .001$), and the 4-year-old group did better than the 3-year-old group ($p < .001$). The interaction effect was not significant, $F(2, 45) = 1.256$, $p = 0.295$. This indicates that the superior performance of text-based inference over knowledge-based inference was consistent across all age groups.

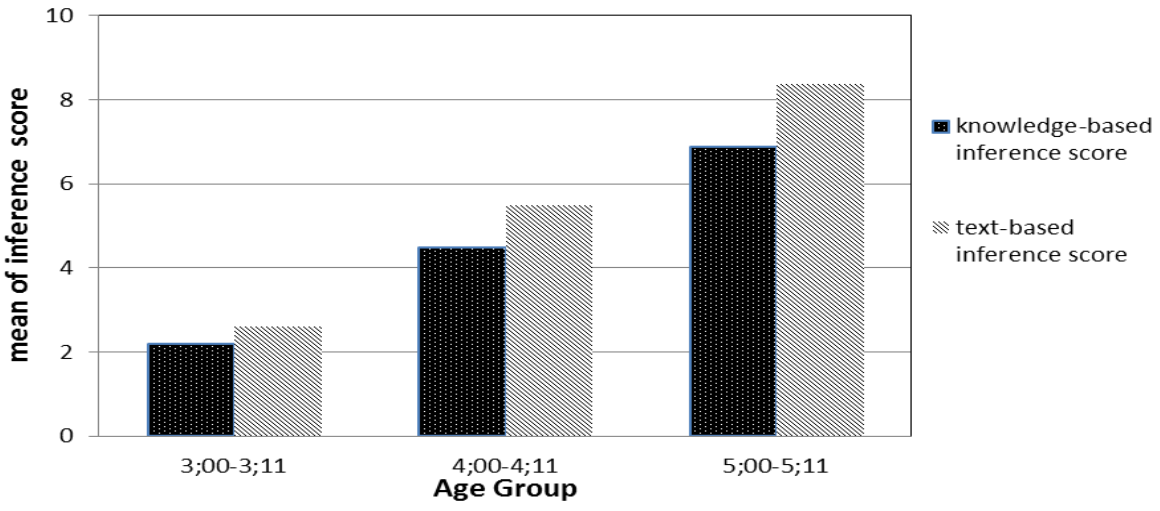

Figure 1. The mean of inferences across age group.

Table 1.

Mean and standard-deviation of the children's performance by age group.

Task			3-year-old group	4-year-old group	5-year-old group	Over-all
Inference score	Knowledge-based**	Mean	2.19	4.50	6.88	4.52
		SD	1.05	2.19	1.77	2.57
	Text-based **	Mean	2.62	5.50	8.38	5.50
		SD	1.71	2.28	1.67	3.02
	Text-based: Causal*	Mean	0.75	1.88	2.50	1.71
		SD	0.77	1.03	0.89	1.15
	Text-based:	Mean	0.75	2.50	3.62	2.29
	Character's emotion*	SD	0.93	1.46	0.62	1.58
	Text-based:	Mean	1.13	1.19	2.38	1.56
	Referential*	SD	0.72	0.91	1.15	1.09
RDLS-R		Mean	48.19	53.31	60.38	53.96
		SD	4.17	4.76	2.60	6.36
Backward digit span		Mean	2.65	3.34	3.84	3.28
		SD	0.38	0.51	0.57	0.69

** Maximum score = 12 points; * Maximum score = 4 points.

Specific type of text-based inference

The age groups (3) X types of text-based inferences (3) ANOVA revealed that there was a significant main effect of text-based inferences, $F(2,90) = 8.91$, $p < .001$. Post hoc pairwise comparison revealed that children performed better in character's emotion inference

significantly better than causal ($p < .05$) and referential inferences ($p < .05$), while performance difference between causal and referential inferences were not significant ($p = 1.00$). There was also a significant main effect of age groups, $F(2,45) = 37.50$, $p < .001$. Post-hoc multiple comparison revealed that the 5-year-old group did better than the 4-year-old group ($p < .001$) and the 3-year-old group ($p < .001$), and the 4-year-old group did better than the 3-year-old group ($p < .001$).

The interaction effect was significant, $F(4,90) = 5.04$, $p < .01$. Figure 2 illustrated the performance differences among text-based inferences varied across age group. Post Hoc simple effect anaylsis revealed that the minial performance difference in 3-year-old group among three types of text-based inference were not significant ($p = 1.0$; $p = .26$; $p = .28$), even though slightly higher score was noted in referential inference.Signficant performance differences were noted among all text-based inferences in the 4-year-old group, with better performance in character's emotion inference score over causal inference ($p < .05$) and referential inference ($p < .001$) while performance on causal was better than referentail inference ($p < .05$). The 5-year-old group scored demosntrated the similiar pattern of performance difference seen in 4-year-old group that performance in character's emotion inference score superior causal inference ($p < .001$) and referential inference ($p < .001$); however, performed difference between causal than referentail inference was not significant ($p = 0.71$). Looking at development of each text-based inference, significant increase in

scores between the 3 and 4-year old group in causal ($p < .05$) and character's emotion inference ($p < .001$), whereas not significant increase in scores for referential inference was noted ($p = 0.9$). The 5-year-old group performed significantly better than the 4-year-old group in making charater's emotion ($p < .001$) and referential inference ($p < .05$), while age difference in making causal inference was not significant ($p = .06$). In addition, the 5-year-old group performed signitifcantly better than 3-year-old group in all three types of text-based inference ($p < .05$).

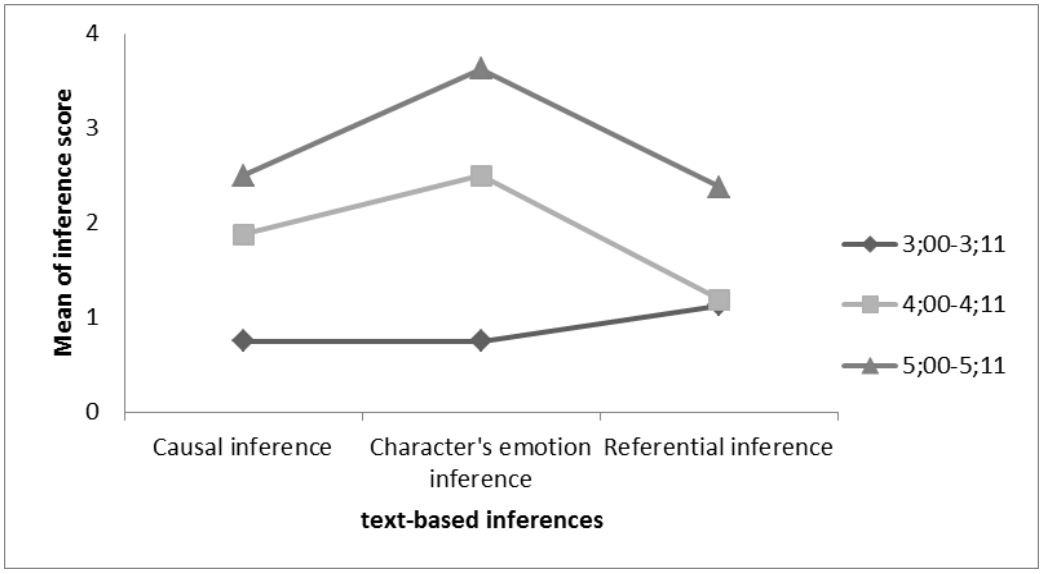

Figure 2. The mean of text-based inference scores across age group.

Contribution of working memory and receptive ability in inference generation

According to Cohen (1988), the Pearson Correlation coefficient revealed strong positive correlation between overall inference score with 1) backward digit span, $r = 0.75$, $p < .001$; 2) RDLS-R, $r = 0.825$, $p <. 001.$; and 3) age, $r = 0.872$, $p < .001$. A strong positive correlation was also revealed between age and RDLS-R, $r = 0.833$, $p < .001$. Whereas a moderate

positive correlation was noted between 1) age and backward digit span, $r = 0.552$, $p < .001$; and 2) RDLS-R and backward digit span, $r = 0.552$, $p < .001$.

Two separate multiple regressions were run to explore the contribution of age, backward digit span and RDLS-R to children's inference generation ability. In set 1, age was entered as the first step, RDLS-R as second step and backward digit span as third step. The R square value indicated that age alone accounted for the 76% of the variation in inference making, $F(1,46) = 146.0$, $p < .001$, understandably given the children were from three different age groups. Each of RDLS-R and backward digit span accounted for relatively lower amount of the variation in inference making; the former was entered as second step added an additional 3.2% variance, which was significant, $F(1, 45) = 6.85$, $p < .05$ and the latter was added as the last step contributed another 3.6% variance, which was also statistically significant $F(1,44)=9.162$, $p < .01$. In set 2, age was entered as the first step, backward digit span as second step and RDLS-R at sentence level as third step. The R square value consisted with set 1 such that backward digit span and RDLS-R each has accounted for unique significant amount of variance for inference making; adding an additional 2.4% variance, $F(1,45) = 5.0$, $p < .05$ and 4.4% of variance, $F(1,46) = 11.1$, $p < .001$ respectively. Overall, standard coefficient beta value revealed RDLS-R ($\beta = 0.384$, $p < .01$) made more contribution than backward digit span ($\beta = 0.286$, $p < .01$).

The contribution of RDLS-R and backward digit span on knowledge-based and

text-based inferences were further examined by another two separate multiple regression. In multiple regressions investigating knowledge-based, age was entered as the first step, RDLS-R as second step and backward digit span as the last step. The R square value indicated that even when the backward digit span was entered as third step, it added an additional 5.2% variance, which was significant, $F(1,44) = 7.895$, $p < .01$, while second step of RDLS-R added 1% of variance which was not significant, $F(1,45) = 1.323$, $p = 0.27$.

Another multiple regressions on text-based inference, age was entered as the first step, backward digit span as second step and RDLS-R as third step. The R square value indicated that even RDLS-R was entered as third step, it added an additional 5.2% variance, which was significant, $F(1, 44) = 8.765$, $p < .01$ while second step of backward digit span score added 1.1% of variance which was not significant, $F(1,45) = 1.566$, $p = 0.217$.

Discussion

Performance in text-based inference and knowledge-based inference across age groups

It was found that older children performed better at both generating knowledge-based and text-based inferences than younger children. Gradual development of generating both types of inference were noted across the age group examined. In 3-year-old group, scores for both types of inferences were low, revealed that skills in generating both types of inferences were limited and yet developed in 3-year-old children. By anecdotal observation, majority of the responses of 3-year-old children were extracted literally from the story without further

manipulation and interpretation of this information to form inference. Whereas, in 4-year-old group, clear evidence of early emergence of inference generation skills were noted with the significantly higher score comparing with the 3-year-old group, that the 4-year-old children were readily development skills generate both types of inference. With significant higher scores, the 5-year-old group children were more skilful in inference generation and they were approaching acquisition of inference generation skills.

One of the major findings of this study is that children across age groups performed better in generating text-based than knowledge-based which appears to contrary to the original hypothesis. Result in Wong (1994) did not hold given as discussed in the introduction, one reason may be due to the difference in difficulty level of the knowledge-based inference in the study and current study; with knowledge-based inference in Wong (1994) being easier due to presence of cues in questions and inferences were draw regardless of the story content. These current results supported our initiation query and revealed when children were required to incorporated previous knowledge which was implicit in the both story content and questions, to the specific information in story content, without additional cueing, it turned out the knowledge-based are more difficult to generate than text-based inference for pre-schoolers. The difference in results may also attribute to the difference in number of inference trials between the two studies. The current study contained more number of trials in both knowledge-based and text-based inferences than Wong (1994), such that a greater range

of scores and performance difference across age groups and between the two types of inferences could be seen.

The performance difference between knowledge-based and text-based inferences may be further explained by the variation in the nature and cognitive processes involve when drawing the two types of inferences. According to Graesser et. al (1994), text-based inference can be generated online with the process of building the mental representation by identifying meaningful relations between pieces of information within the text whereas knowledge-based inference, demands higher cognitive processing ability and loading. That is, knowledge-based inference involves the process in activation of previous learnt relevant information stored in long-term memory, then form meaningful relation with specific information in the mental representation of the text. Yet for pre-schooler, their cognitive processing ability are still at stage of early development, hence, knowledge-based inference would be more challenging for them than text-based inference.

Another possible explanation on why knowledge-based inference appears to be harder may be related to the extent of previously learnt knowledge or experience that individual children possessed (Winner, 1980). Based on the anecdotal observation, when the children recalled their own experience related to the story theme after the task, the 3-year-old group could only recall with limited extent of information whereas children with age 4 onwards tended to recalled with extensive amount of information regarding their experience around

the theme. Therefore, it reflected that performance in knowledge-based inference of 3-year-old children may be hindered by both inadequate cognitive processing ability and insufficient of knowledge of the events; whereas for 4- and 5-year-old children's performance may be mainly attributing to the developing cognitive processing rather than insufficiency of backward knowledge.

Performance in specific text-based inferences across age groups

One of the important finding in this study is the performance difference among three types of text-based inference and the performance difference varied across age groups. The ability of the 3-year-olds in generating text-based inference was overall weak and closed to floor effect. As no significant difference was noted among the three types in 3-year-old group, the focus of the following discussion explored performance difference among text-based inference 4-year-old and 5-year-old group.

A development trend among the three types of text-based inferences has been found in the 4-year-old group. At aged 4, early emergency of character's emotion and causal inferences were noted; whereas referential was yet develop and performance corresponsively remained as in age 3. At aged 5, character's emotion inference continued the course of development gradually while causal inference was developing at a relatively slower pace. In addition, early development of referential inference was noted and pursued with the development of causal inference.

The performanc difference among the text-based inferences may be explained by refereing to how do these inferences differ particular in two aspects: the moment during listening at which inference in made and the direction of inference is formed, proposed by Cozijn (2000). The three types of text-based inference were generated at different moments during listening; character's emotion inference was generate at the moment once the initiating event of emotion was presented but the casual inference was made once after both the cause and the consequence were presented. Whereas, for referential inference, it was draw at moment once the pronoun was processed in the attendant sentence. However, in story, referential inference has to interrelated to multiple sentences and maintain throughout plot to establish coherence of story. This may explain why referential inference may be harder for pre-schooler and develop at an older age than casual and character's emotion references.

Furthermore, the performance of character's emotion inference superior to causal and referential inference may also be explained by the notion proposed by Cozijn (2000). This notion illustrated that inferences are differed in the direction which they are formed considering the connection of the pieces of information; some are made in forward direction and the others are made in backward direction, with the former one potentially being easier. Inference formed in forward direction are made corresponding to the flow of story whereas inferences formed in backward direction are formed in a reversal direction against the proposition order of which the information was presented. According to this notion, it is

suggested that causal and referential inference are both formed in a backward direction; the former requires children to relate the pronoun in the attendant sentence with previous phrase and the latter requires them to correlate the consequence with the cause which presented in adjacent sentences. On contrary, character's emotion inferences are formed in forward direction as children deduce the emotion subsequently to the initiating event, which would be easier than the other two types of inferences.

One other explanation of the performance difference among the text-base inferences across age may attribute to the development of skills in various aspects which are necessary in process of generating these text-based inference. The results revealed early emergency of character's emotion and causal inference at age 4 was consistent with Bee (2000), that children started to develop perspective-taking and could correlate other's behavior with their emotion and motives at around age 4. In addition, notion in van den Broek (1989) supported the result on character's emotion inference, that as age increases, children deepen knowledge about emotions through wider range of social event experiences. Hence, older chileren could be more easily integrat into story characters' persceptive to generate character's emotion inference. This may also explain why character's emotion inference remained as the best performed text-based inference in 5-year-old group children and were approaching celling effect when causal and referential inference were still at a developmental stage. Furthermore, ability in generating causal inference may be attributed to development of higher cognitive

abilities such as reasoning skills which has yet developed in age 3.

The result revealed referential inference may be develop later than other two types in age 5, which may be accounted for the adequacy of linguistic skills in preschooler. In addition, another possible explanation may be related to the nature of how referential inference was drawn in Cantonese. In Cantonese, the same pronoun "佢" is used for all characters in the story disregarding the gender whereas in English, the pronoun "he or she" itself reveals information of character and gives cues in making inferetial inference. Therefore, this difference suggested that referential inference in Cantonese is harder to generate in comparison to English, as children have to generate the referential inference based on the context of story but not based on the pronoun itself.

Contribution of working memory and receptive ability in inference generation

Current study also found a strong correlation between inference generation ability and working memory on one hand, and receptive ability on another hand. The result agreed with the "theory of inference Generation" (Graesser & Kreuz, 1993) which suggested people's world knowledge, cognitive mechanisms like reasoning skills and abilities to constrain their interpretation text information contribute to the process of making inference. The current result extended from the previous evidence of a strong correlation between listening comprehension and working memory in pre-schooler (Adam et.al, 1999), that working memory also has a unique contribution to inference generation.

The result answered the initiate questions arose on which of these factors are more important for inference generation. Apart from age, receptive ability made more contribution than working memory in explaining the variance of inference generation. This result was consistent with the finding in Florit and Levorato (2011), that both age and verbal ability contribute to a larger extent to listening comprehension and memory skills make a though unique, but a smaller contribution, even if it is not a large one, to listening comprehension in pre-schooler.

The current study further explored the contribution of working memory and receptive ability of sentence level in generation of knowledge-based and text-based inference. The result revealed that working memory specifically contributed to knowledge-based inference over receptive ability whereas on contrary, receptive ability specifically contributed to text-based inference over working memory. The difference may be explained by the different processes involved when drawing these inferences. Knowledge-based inference relies more on working memory to actively integrate stored information from long-term memory with the mental representation built on the basis of comprehension of explicit information. While, text-based inference relies more on one's receptive ability to interpret and manipulate the pieces of explicit information.

In conclusion, the results revealed that pre-schoolers performed better in generating text-based inference than knowledge-based inference, and found that children early

emergency in forming inference in oral text was at age 4. The development of specific types of text-based inferences differed; that character's emotion inference was more easily acquired than causal and least with referential. Early development of character's emotion and casual inference was evidenced at age 4 whereas referential inference emerged at age 5. Furthermore, unique contribution of working memory and receptive ability in inference generation was found. Specially, the former contributed greater in knowledge-based inference whereas the latter explained more in text-based inference.

Implication for Further Research

This study serves to provide preliminary data on the development of inference in oral text comprehension in Cantonese-speaking preschoolers. van den Broek et. al (2005) suggested that very young children can generate all types of inference but they generally need the inferences involved to be less complex and more supported by text or background knowledge than do older children. In this study, floor effect of 3-year-old children's performance in drawing inference. This indicated that the task or the stories designed in this study may difficult for them to make inference. Further investigation of 3-year-old or below can be explore through different materials instead, to gain better insight on development of inference skills. In addition, this study used the backward digit span task to evaluate children's working memory. However, the performance of age 3 children may be affected by

their understanding of the task due to the complicity of the task. In future, examination on working memory in young children may be conducted by simpler task.

Clinical implication

The study provided insight about the trend of development in different types of inference in pre-schooler; this information could be useful in distributing the normal data set in the future. The sets of stories and questions designed in this study could be helpful to future development of resource in examination of inference generation in pre-school population. In consequence, early preventive intervention could be given to avoid future implication in reading comprehension. Exploring the specific role of working memory and receptive ability in inference generation may reveal and explain the roots of client's difficulty in generating inference and which may lead to more effective intervention.

Acknowledgement

I would like to thank Dr. Anita Wong for her valuable comment on this project and Ms Angeline Tsui for her advice on data analysis. Furthermore, I would like to thank all the principals and children of the following pre-school for their participation in this study: Christian Little Angel Kindergarden (Kam Fung Count), CUHKFAA Thomas Cheung Kindergarden and CCC Chai Wan Church Day Nursery. Lastly, but most importantly, I want to express great thanks to my classmates for their support and help in this dissertation.

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Appendix 1

Cantonese version of Story 1"志仔" with questions & scoring criteria

今日係個好特別嘅日子, 志仔收到好多禮物呀, 媽媽買咗個大蛋糕俾志仔添。佢好大力咁吹熄啲臘燭, 佢食咗蛋糕仲飲咗啲牛奶, 佢諗: "唔, 點解啲牛奶酸酸哋㗎呢?", 但喺佢都繼續飲。無幾耐之後, 志仔就覺得個肚有啲痛啦。媽媽就話:" 唔, 咁你要係屋企休息吓啦, 我地唔去海洋公園啦。"

Types of inference	Question:	Target answer (pont 1)
Knowledge-based	故事裡面, 係咩特別日子?	志仔生日
Knowledge-based	啲臘燭插係邊度㗎?	蛋糕上面
Text-based (referential)	邊個吹熄啲臘燭?	志仔
Knowledge-based	點解啲牛奶酸酸哋?	牛奶壞咗/過期
Text-based (causal)	點解志仔會肚痛?	飲左酸酸哋嘅牛奶/壞咗嘅牛奶
Text-based (charater's emotion)	冇得去海洋公園, 志仔嘅心情點樣?	唔開心/失望

Cantonese version of Story 2 "家明" with questions & scoring criteria

媽咪幫家明著咗外套同帶咗頸巾之後,就帶家明去玩滑梯同盪鞦韆 wo3。過左一陣,佢地玩到好攰啦就坐喺凳度休息。lei1 個時候呢, 有個小朋友攞住架玩具飛機行過 wo3, 家明就跟住個小朋友行開咗啦。家明行行下"咦! 唔見咗媽咪嘅!"。最後呢, 警察叔叔幫家明打電話搵番媽咪。

Types of inference	Question:	Target answer (point 1)
Knowledge-based	故事裡面, 天氣係點?	好凍, 大風, 冬天
Knowledge-based	家明, 媽咪去左邊度玩?	公園/遊樂場
Tex-based: Referential	邊個坐咗係凳度休息?	媽媽,家明
Text-based: Causal)	點解家明唔見咗媽媽?	跟住個小朋友行開咗
Text-based: Character's emotion	唔見左媽咪, 家明嘅心情點樣?	好驚／擔心/ 唔開心
Knowledge-based	點解警察叔叔會係街度?	幫人/巡邏/捉壞人

Appendix 2

English version of of Story 1 "Zi Zai*" with questions & scoring criteria:*

"Today is a special day. *Zi* Zai received a lot of presents and his mother brought him a cake. He blew out the candles. He ate a piece of the cake and drank some milk. He thought to himself "Why does the milk taste so sour?" and kept drinking it nevertheless. After a while, *Zi* Zai had a stomachache. *Zi* Zai's mother said "Oh, you should rest at home, we will not go to Ocean Park.

Types of inference	Question:	Target answer (point 1)
Knowledge-based	What special day is it?	Zi Zai 's birthday
Knowledge-based	Where is the candle placed?	On top of the cake
Text-based (referential)	Who blew the candle?	Zi Zai
Knowledge-based	Why do you think did the milk taste sour?	The milk was expired.
Text-based (causal)	Why do you think Zi Zai has stomache?	He drunk sour/ expired milk.
Text-based (charater's emotion)	Zi Zai can't go to Ocean Park, how would he feel?	sad/disappointed

English version of Story 2 “Ka Ming” with questions & scoring criteria

After Ka Ming’s mother helped Ka Ming put on the jacket and the neckerchief, she brought him to play on the slide and swings. After a while, they sat on the bench to rest. At this moment, a boy holding an aeroplane walked passed them, then Ka Ming followed the child and walked far away. Ka Ming realised “Oh, where is my mother?”. Finally, a policeman helped him to call and find his mother.

Types of inference	Question:	Target answer (point 1)
Knowledge-based	In the story, what’s the weather like?	Winter/ cold/ windy
Knowledge-based	Where did Ka Ming and his mother go?	Park/ playground
Tex-based: Referential	Who sat on the bench?	Ka Ming and his mother
Text-based: Causal)	Why did Ka Ming get lost?	He followed another child/ boy and walked away.
Text-based: Character’s emotion	Ka Ming can’t not find his mother, how would he feel?	Worry/ scared/ sad
Knowledge-based	Why was the policeman on the street?	Patrol/ catch thief/ help people out